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Committee on the Peaceful Uses of Outer Space

National research on space debris, safety of space objects with nuclear power sources on board and problems of their collisions with space debris

Note by the Secretariat

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I. Introduction

1. At its forty-third session, the Committee on the Peaceful Uses of Outer Space agreed that Member States should continue to be invited to report to the Secretary-General on a regular basis with regard to national and international research concerning the safety of space objects with nuclear power sources, that further studies should be conducted on the issue of collision of orbiting space objects with nuclear power sources on board with space debris and that the Committee's Scientific and Technical Subcommittee should be kept informed of the results of such studies.[1] The Committee also took note of the agreement of the Subcommittee that national research on space debris should continue and that Member States and international organizations should make available to all interested parties the results of that research, including information on practices adopted that had proved effective in minimizing the creation of space debris (A/AC.105/736, para. 96).

2. Pursuant to the recommendation of the Committee, in a note verbale dated 26 July 2000, the Secretary-General requested Governments to submit any information on the above questions by 31 October 2000 so that it could be submitted to the Scientific and Technical Subcommittee at its next session. The present document has been prepared by the Secretariat on the basis of information received from Member States by 24 November 2000. Information received subsequent to that date will be included in an addendum to the present document.

II. Replies received from Member States and international organizations

Oman

[Original: English]

Oman carries out no research on space debris or the safety of nuclear-powered satellites.

Peru

[Original: Spanish]

Since Peru does not have a payload space launch capability, the topic of space debris mitigation is being considered solely from the point of view of the actual payload. In that specific context, the CONIDASAT-01 project, which is a satellite project of the National Aerospace Research and Development Commission (CONIDA) involving the design and construction of an Earth observation mini-satellite, takes into account all the factors that can help prevent the creation of debris in space as a result of the satellite's launch and operation.

[1] *Official Records of the General Assembly, Fifty-fifth Session, Supplement No. 20* (A/55/20), para. 99.

United Kingdom of Great Britain and Northern Ireland

[Original: English]

1. Introduction

1. The continued commitment of the British National Space Centre (BNSC) to addressing the space debris issue is outlined in its United Kingdom Space Strategy report (1999-2002). A key objective is to coordinate with other agencies that are also working on the threat posed by space debris. In that regard, BNSC coordinates United Kingdom activities (through the United Kingdom Space Debris Coordination Group (UKSDCG)) and ensures that they are harmonized with those of the European Space Agency (ESA) and its member States. Through its membership of the Inter-Agency Space Debris Coordination Committee (IADC), BNSC is actively pursuing international agreement on major space debris issues. It also supports the related programme of work of the Committee on the Peaceful Uses of Outer Space.

2. UKSDCG provides a forum for the coordination of all United Kingdom debris research activities. The group enables researchers to exchange information and ideas and, where possible, fosters collaborative opportunities. The next meeting will be attended by all of the major United Kingdom debris research groups from industry and academia. These include the Defence Evaluation and Research Agency (DERA), Astrium, Century Dynamics, Fluid Gravity Engineering, the Ministry of Defence and the Universities of Kent, London and Southampton.

3. IADC is an international forum for cooperation on all aspects of the debris problem. In particular, efforts within the group are focused on achieving agreement on recommended mitigation practices based on sound technical analysis of the debris problem. The United Kingdom has participated in two full meetings of IADC, the first hosted by ESA in Germany in October 1999 and the second hosted by the National Aeronautics and Space Administration (NASA) in the United States of America in June 2000. At the June meeting, BNSC offered to host the IADC meeting due to be held in 2002.

4. The United Kingdom has particularly strong debris research capabilities, which BNSC regularly calls upon for impartial technical support and advice. During the past year, United Kingdom organizations have conducted the research and development described below.

2. Measurement of the debris population

Debris detectors

5. Real-time detection in space offers valuable insight into the space debris and meteoroid environment. The detection method typically utilizes the energy of an impacting particle to trigger a measurement. The Unit for Space Sciences and Astrophysics at the University of Kent at Canterbury has maintained progress on three flight opportunities for a space debris detector known as DEBIE. For the first of those opportunities, a Finnish consortium is assisting with the construction of a unit in readiness for a flight on ESA's Project for On-Board Autonomy (PROBA) spacecraft. On the second flight opportunity, DERA's Space Technology Research Vehicle-1c (STRV-1c) satellite, all units have been integrated onto the spacecraft and launch is scheduled for the third quarter of 2000. The final flight opportunity is

on the International Space Station. The launch on ESA's Technology Research Exposure Facility will be in June 2002, with a flight duration of three years and subsequent return to Earth. This provides a rare opportunity for post-flight inspection of the retrieved surfaces.

Debris environment modelling

6. Modelling of the debris environment, its long-term evolution and the potential risks it causes to possible future space systems continues to be a major activity amongst United Kingdom debris researchers. The effect of continually introducing new assets into near-Earth space, and therefore the consequences for the debris environment, is also a key research area.

(a) Modelling the debris environment in low-Earth orbits

7. DERA's Integrated Debris Evolution Suite (IDES) debris model has been used extensively to study the long-term evolution of the low-Earth orbit (LEO) debris environment in high resolution, including the influence of LEO satellite constellations and debris mitigation measures. In particular, the model has supported BNSC participation in a number of important studies within IADC. Subsequently, the following general conclusions were reached:

(a) The deployment of hundreds of constellation satellites within a narrow altitude band will have a significant impact on the LEO debris environment, especially if no post-mission disposal is performed by constellation satellites. Constellation satellites must perform some form of post-mission disposal to remove them from the constellation operational altitude;

(b) Some form of post-mission disposal is needed in addition to passivation in LEO;

(c) The use of storage orbits in or above LEO is not recommended because of the predicted initiation of collisions in those storage orbits within a 100-year projection period and, in the absence of atmospheric drag, the storage orbit will become unstable after collisions start to occur;

(d) Both 25- and 50-year post-mission residual lifetimes for de-orbiting were predicted to be efficient in reducing future population growth. However, the lowering of perigee altitude to achieve those residual lifetimes has caused a long-term increase in catastrophic collision risk at manned mission altitudes. There was concern about de-orbit perigees located at or slightly below the altitudes of Mir and the International Space Station.

8. Further studies are needed before firm mitigation strategy recommendations can be made and international consensus reached.

9. The success of the IDES model also led ESA/European Space Operations Centre to issue a contract to DERA to develop an IDES-type model for use in ESA. The new model, called DELTA, was delivered to ESA in early 2000. DELTA provides long-term projections of the >1 mm LEO debris environment and associated mission collision risks over the next 100 years. It is already regarded as one of the most sophisticated models of its kind.

(b) Modelling the debris environment in high-Earth orbits

10. Whereas models of the current debris environment in LEO are becoming quite thorough, at high altitudes such as geostationary orbit there is much more uncertainty. An international consortium comprising the University of Kent, DERA, Onera (Toulouse), the Max Planck Institute (Heidelberg, Germany) and the University of Maryland has been awarded an ESA contract to extend modelling of space debris and other environmental factors from LEO to geostationary orbit. This work is ongoing and is due to be reported on in the next few months.

11. During the past year, the University of Southampton has been awarded a three-year grant by the Engineering and Physical Sciences Research Council to construct high-resolution models of the long-term debris environment in the geostationary orbit and neighbouring orbits. The model will include the ability to assess the collision risks to orbiting systems. This activity is the main focus of debris research at Southampton.

12. In parallel with the Southampton geostationary orbit model development, DERA is also extending the capability of its IDES model from LEO to geostationary orbit. In the spirit of cooperation, the research teams at DERA and Southampton are maintaining an active dialogue and exchange of ideas during this time.

(c) Short- and medium-term debris risks to space assets

13. The University of Southampton actively undertakes short- and medium-term debris risk assessments of major space assets using its space debris software tool (SDS). Recently, SDS has been applied to determine the medium-term (one-month) collision risk to a LEO constellation posed by the break-up of one of its member satellites. Results of the study will be presented at the International Astronautical Federation (IAF) 2000 congress in Brazil.

4. Spacecraft debris protection

14. The protection of spacecraft from hyper-velocity debris impacts is another research area in which the United Kingdom is very active.

(a) Satellite survivability modelling

15. DERA has continued to develop an innovative software model called SHIELD. The purpose of SHIELD is to evaluate the survivability of unmanned spacecraft designs and recommend appropriate cost-effective debris protection strategies. Version 1.0 of SHIELD has just been completed and is undergoing validation. A paper describing SHIELD was published at the IAF 1999 conference in Amsterdam and an invited paper illustrating some results from the model is due to be presented at the IAF 2000 congress in Brazil.

(b) Hyper-velocity impact assessment

16. Century Dynamics continues to develop and market a user-friendly hydrocode simulation tool called Autodyn to investigate hyper-velocity impacts on spacecraft structures. Recent improvements to Autodyn include material models for new materials such as Nextel and Kevlar and the addition of a technique known as smooth particle hydrodynamics.

17. Under contract to ESA, a United Kingdom consortium led by Astrium (UK) has investigated cost-effective debris shielding solutions for unmanned spacecraft. New structures, including a double honeycomb configuration and enhanced multi-layer insulation, were analysed and tested. Results showed that noticeable improvements in survivability could be achieved at relatively low cost.

International Astronomical Union

[Original: English]

The International Astronomical Union (IAU) has long regarded the accelerating interference from space debris as a serious threat to the space environment and the future of observational astronomy. IAU warmly welcomes the decision of the Committee on the Peaceful Uses of Outer Space to initiate a substantive discussion on practical debris mitigation measures and will follow it with great interest. Given the nature of IAU, members of the Union contribute to the subject as part of their professional activity in national and international space agencies, but IAU does not conduct an independent programme in the area.